DOCUMENT RESUME

ED 202 722 SE 035 149

AUTHOR	Fortner, Rosanne W.; Ihle, Stephanie
TITLE	Oil Spill! Student Guide and Teacher Guide. OEAGLS Investigation 17.
INSTITUTION	Ohio State Univ., Columbus. Research Foundation.
SPONS AGENCY	National Oceanic and Atmospheric Administration (DOC), Rockville, Md.
PUB DATE	Mar 80
GRANT	NOAA-04-8-M01-170; NOAA-04-158-44099; NOAA-NA-79AA-D-00120
NOTE	34p.; For related documents, see SE 035 140-155 and ED 179 352-358. Prepared in collaboration with the Ohio Sea Grant Program.
AVAILABLE FROM	Ohio Sea Grant Education Office, 283 Arps Hall, Ohio State Univ., 1945 N. High St., Columbus, OH 43210 ($1.00 plus $1.00 per order for shipping).
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Ecology; Energy; *Environmental Education; Fuels; *Marine Biology; *Pollution; Science Course Improvement Projects; Science Education; *Secondary Education; *Secondary School Science; Water Resources
IDENTIFIERS	Environmental Protection; Great Lakes; *Oceanic Education Activities Great Lakes Schools; Ohio Sea Grant Program

ABSTRACT

Presented in this unit are three activities concerning the causes and effects of oil spills and methods used to clean up these spills in the oceans and Great Lakes. Students construct and interpret a graph showing oil pollution sources. The students create and try to clean up a small-scale oil spill in a pan, and they compare the water quality of clean and oily water. Both a teacher's guide and a students' guide are provided. Included in the teacher's manual are a materials list, objectives, recommended teaching approaches, evaluation items, and answers to questions contained in the student workbook. (Author/WB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED202722

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Rosanne Fortner
Raymond S. Bugno

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

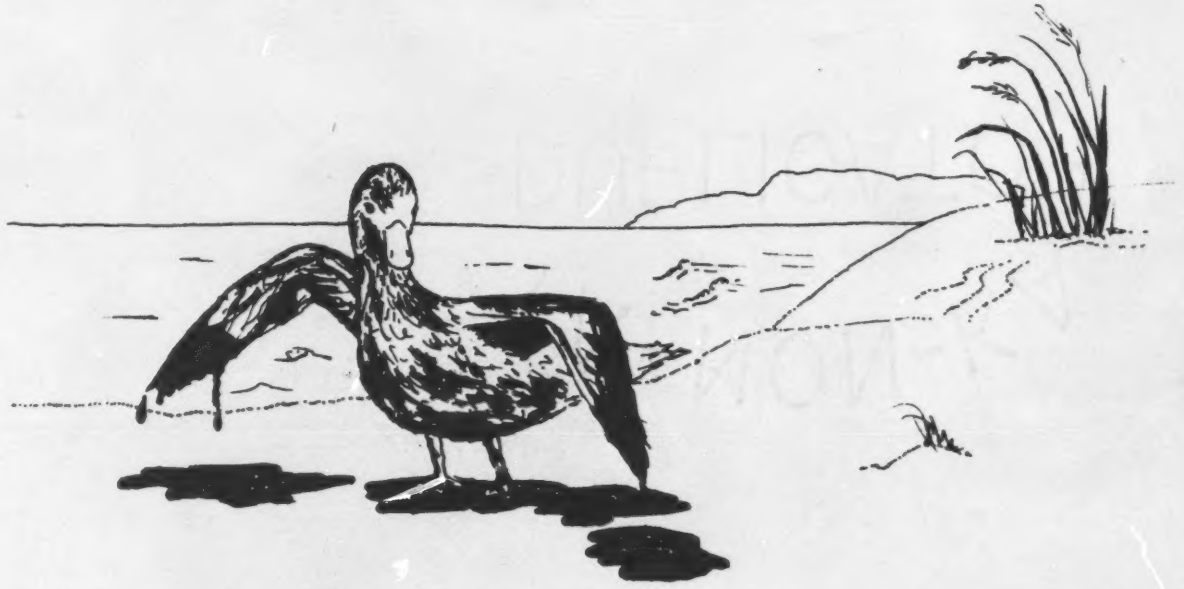
Ohio Sea Grant

OEAGLS- Oceanic Education Activities for Great Lakes Schools

OIL SPILL!

by

Rosanne W. Fortner, The Ohio State University
and
Stephanie Ihle, The Ohio State University



Ohio Sea Grant Program
Charles E. Herdendorf, Program Director
Victor J. Mayer, Principal Investigator

SE 035 149

OEAGLS Investigation #17
Completed March, 1980

This instructional activity was prepared with the support of National Oceanic and Atmospheric Administration Grant Nos. 04-158-44099, 04-8-M01-170 and NA 79AA-D-00120, and from The Ohio State University. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the authors, and do not necessarily reflect the views of NOAA or the University.

Copyright © The Ohio State University Research Foundation, 1980.
All rights reserved.

THE OIL SPILL PROBLEM

INTRODUCTION

When oil is poured on rough waters, the surface of the water is calmed. In ancient Greece, sponge divers made use of this fact by carrying oil in their mouths when they began a dive. Releasing the oil smoothed the ripples and gave them better light for searching below. Today, mariners will sometimes dump oil to calm ocean waves and make rescue easier.

Oil on water is not always welcome, however. Accidents in which oil is spilled in the water definitely do not have a calming effect on people. Our recent history records a distressing number of tanker spills, offshore drilling accidents and mysterious oil slicks of unknown origin.

The Great Lakes, as well as the ocean, have been affected. In 1974, for example, an oil spill from the tanker Imperial Sarnia caused damages to the St. Lawrence Seaway which cost about $2,000,000 to clean up. In 1961 another tanker spill on the St. Lawrence River was reported to have caused the extinction of the last colony of Greater Snow Geese.

Who or what is responsible for our oily waters? What are the effects of oil spills on living things in the water? Can an oil spill ever be completely cleaned up?

OBJECTIVES

When you have completed this investigation you will be able to:

1. Describe the major sources of oil pollution in our oceans and the Great Lakes.
2. Discuss three ways in which oil may be removed from water.
3. Describe the effects of oil on aquatic organisms.

ACTIVITY A

WHERE DOES OIL POLLUTION COME FROM?

COPYRIGHTED CARTOON REMOVED.

In 1975 the U.S. National Academy of Sciences estimated that 6,100,000 metric tons of petroleum products enter the world's oceans each year. (This is usually written as 6.1 mta.) More recent estimates are still close to this amount. About 2.3% of this total, or 0.14 mta, comes from oil spills in the Great Lakes. The petroleum pollution comes from many sources, some natural and some from human activities.

MATERIALS Protractor, pencil, circle in Figure 1.

PROCEDURE In this activity you will construct a "pie" graph showing what part of the total petroleum pollution in the oceans comes from different sources. The list on the next page tells how many million metric tons anually (mta) come from different sources. It also tells what percent of the total petroleum pollution this is.

The whole circle in Figure 1 represents the 6.1 mta discussed. You will divide the circle into wedges that look like pieces of pie. The size of each wedge will depend on the amount of petroleum from one source.

To find how big a wedge to draw, you will have to do an arithmetic problem.

1. A circle can be divided into 360 equal parts called degrees. Multiply the percent (column 2) by 360 and write your answer in column 3. If one pollution source is responsible for 10% of the total oil pollution, you would multiply 0.10 (same as 10%) x 360°. Your answer is 36°.

2. Place your protractor on a line running from the center of the circle to its outer edge. The point at the center of the protractor base should be on the center of the circle.

3. Reading from the bottom line of the protractor around the arc, find the point that represents your answer from column 3. Place a dot on the circle at that point.

4. Draw a line from the center of the circle to the edge of the circle through your dot. Label the wedge as shown in the example in Figure 1.

5. Complete the chart below and check your work by adding up the numbers in column 3. The total should be 360°.

6. Divide your pie graph into wedges as the example shows.

Source of Petroleum	mta	% of total	Size of Wedge
Natural seepage*	0.60	10	36°
Tanker operations	1.33	22	
Tanker accidents	0.20	3	
Other transportation activities	0.60	10	
Runoff from rivers and cities	1.90	31	
Coastal facilities	0.80	13	
Offshore drilling	0.08	1	
Atmospheric fallout	0.60	10	
Total	6.11	100%	

(Data from U.S. National Academy of Sciences, Petroleum in the Marine Environment. Washington, D.C., 1975.)

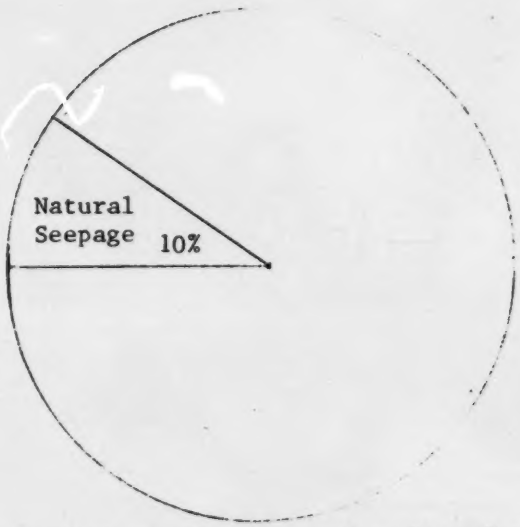
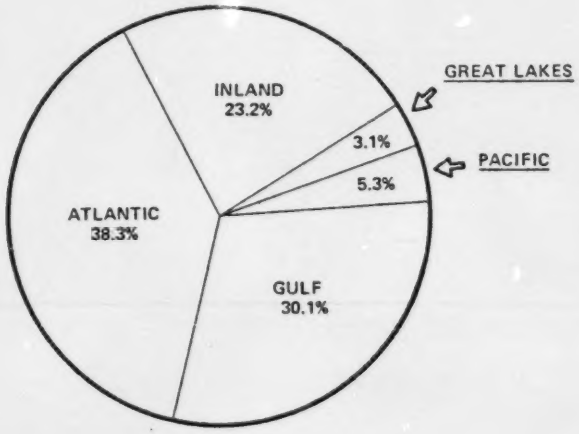


Figure 1. Sources of petroleum going into the oceans.

*Leaks from oil deposits. In the Great Lakes, for example, oil seeps into the water from deposits at Oil Springs, Ontario.

Now look at Figure 2. In this second pie graph you can see how the oil pollution was distributed in the waters of the world in 1976. Notice that the wedge for the Great Lakes is almost as big as the one for the Pacific Ocean. The area of the Pacific Ocean is about 750 times the area of the Great Lakes. The damage done by the oil pollution in the Lakes is much more concentrated and therefore does more visible damage than Pacific oil pollution.



VOLUME 23,125,714 GALLONS

U.S. Coast Guard, Polluting Incidents in and around U.S. Waters. CG-487, 1976.

Figure 2. Oil Pollution Incidents by Area, 1976.

QUESTIONS

1. Most of the oil spills we hear about involve which one of of the wedges in Figure 1? _____

Compared to other sources of petroleum pollution, this is a very small amount.

Illustration removed due to copyright restrictions.

Occasional massive spills such as the Amoco Cadiz in 1978 and the Argo Merchant in 1976 are almost certainly less damaging to the marine environment than frequent smaller releases of oil in a confined area like a busy harbor. (Notice the size of the "Coastal Facilities" wedge.)

2. When an oil tanker (ship) is carrying no oil, it fills up its cargo space with water so the ship will be stable. A ship getting ready to load on a new cargo will dump the water it was using as ballast. This ballast has picked up oil from the hold, and the oily wastes are flushed out into the harbor.

   Which of the wedges describes this type of pollution source?

   _____

3. How could oil get into the water from offshore drilling operations?

   _____

   _____

   You may wish to read about the Santa Barbara oil spill in 1969. (See Life Magazine issues for February 21 and June 13, 1969). The International Joint Commission (a cooperative agency of the U.S. and Canada) has prohibited drilling for oil in the Great Lakes because of the risks of such a disaster.

4. List some ways that petroleum could get into rivers. _____

   _____

   _____

   The next time you are out riding along the highway, look at the road ahead of you. A well-traveled highway usually has a dark streak running down the center of each lane. The streak is caused by petroleum products such as crank case oil that drips out of vehicles. How could this serve as a source of oil pollution for water? _____

   _____

5. What could your family do as good citizens to reduce the amount of petroleum products going into our water? _____

   _____

   _____

6. From Figure 2, what body of water gets the greatest volume of oil pollution? _____

Look at a world map and notice the countries bordering this body of water and those countries that would use it as a trade route. Why do you think this body of water gets such a large amount of oil pollution? _____

_____

_____

ACTIVITY B HOW CAN AN OIL SPILL BE CLEANED UP

The moment a spill occurs, nature begins cleaning it up. The oil separates into heavier and lighter parts and is spread by wind and currents. Some of it evaporates, like gasoline spilled from the gas pump. Certain types of bacteria called petrophiles consume some of the oil. According to marine affairs specialist E. W. Seabrook Hull, "Within a couple of years no sign of the disaster remains. The oil is gone, and the birds and other marine life are back, as though nothing had happened. This has been shown in the case of the Torrey Canyon, the Wafra, the Arrow, the Argo Merchant, Santa Barbara and numerous other major events."

The sight of oily birds and beaches and the loss of tourist and fishing income make us impatient with the slow dependable processes of a natural clean-up. An oil spill needs to be cleaned up right now. How do we do it?

MATERIALS For each team of students: aluminum "pot pie" pan or finger bowl, water, motor oil, 25-cm piece of twine, handful of straw, handful of sand, alcohol burner, matches, wooden splints, paper towel, liquid detergent, dropper, safety glasses

PROCEDURES Success in cleaning up an oil spill depends upon preparedness and rapid action by the spiller and by Federal, state and local agencies. When a spill occurs, it is reported to the nearest U.S. Coast Guard station. If the spiller does not clean up the pollution, the Coast Guard takes over and the spiller pays the clean-up costs.

In this activity your team will create an oil spill and try various methods of cleaning it up.

I. Containment

If an oil spill is contained in one area, cleanup is easier and less environmental damage is likely to occur. Containment must be done as soon as a spill is detected if it is to be effective.

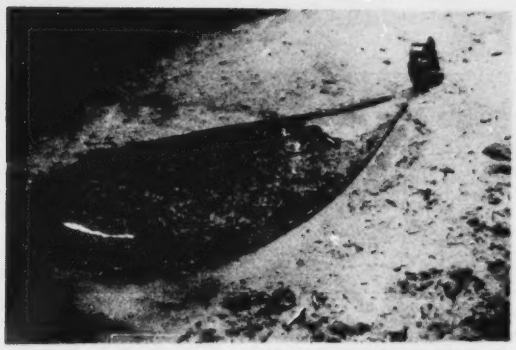
1. Add about 2 cm of water to your pie pan or bowl to serve as a lake.

An oil tanker has sprung a leak in the middle of your "lake." Add 2 drops of oil to the water's surface.

Tie the ends of a piece of string together and gently place the circle of string on top of the water, with the oil inside. Slowly add 2 ml more oil inside the circle.

NOTE: If any oil is spilled outside the pan, clean it up immediately. Spilled oil causes unnecessary accidents.

2. Does the string keep the oil from spreading over the entire lake? _____This is how a "boom" operates to contain a spill.



Crude oil and debris enclosed in a boom

U. S. Environmental Protection Agency, "Oil Spills," 1977.

3. Some contained oil can be reclaimed (collected for further use). Use a dropper to try to reclaim some of your oil. About how much oil were you able to reclaim?

_____

II. Removal of oil from water

Whether the oil is contained or free, it still must be cleaned up to prevent further environmental damage. Although there are many elaborate techniques for oil removal, some simple and non-technical methods are still widely used.

A. Removal by burning

1. Remove the string from your lake. Pour 5 ml of oil on the water surface.

2. Put on safety glasses and light your alcohol burner. Set fire to the tip of a wooden splint. Try to ignite the oil spill with the splint.

3. Does the oil burn? _____If so, how long did it burn? _____Was there any oil left when the flames went out? _____If the oil did not burn, try to explain why. _____

4. If the oil is burned, what other damage to the environment might occur? _____

_____

5. Is the burning of oil an effective way to clean up an oil spill? _____ Explain. _____

_____

_____

B. Removal by sinking

Ordinarily, oil floats on water because it is not as dense as water. Increasing the oil's density will make it sink to the bottom.

1. If your oil was cleaned up in Procedure A, add 5 ml of new oil to your lake.

2. Sprinkle enough sand on the oil spill to cause it to sink.

   Does this method remove all (or most) of the oil from the surface? _____

3. When this method is used, what other effects will it have on the environment?

   _____

4. What should you know about the water environment before using this method to clean up a real oil spill? _____

   _____

5. Is sinking a good way to clean up an oil spill? _____

   Explain. _____

   _____

C. Removal by adsorption

Certain materials will attract oil to their own surfaces. This is called adsorption. You have probably seen pictures of this type of clean up method.

1. Pour 5 ml of new oil into your lake. (You do not need to dump the oily sand from B unless it is deep enough to break the water surface.)

2. Place a small amount of straw on top of the oil. What happens?

_____

Cleaning up an oil-soaked beach.

U. S. Environmental Protection Agency, "Oil Spills," 1977.

3. How can you remove the oil from the lake now? _____

_____Check your idea with your teacher, and try the idea if the teacher approves. Did your idea work? _____

4. Is adsorption a good way to clean up an oil spill?

_____

_____

D. Removal by detergents

Household detergents are used to remove oil from laundry or grease from dishes. They do this by breaking up oil drops and dispersing them in the water to form an emulsion.

1. Dump the contents of your lake in the container provided by your teacher. Wipe the lake basin out and add fresh water.

2. Add one drop of oil and one drop of liquid detergent to the lake. Stir the two together vigorously with a wooden splint. What happens? _____

_____

3. Does dispersion by detergents let you clean up the oil easier? _____ Explain. _____

_____

4. How could the environment be damaged by use of detergents?

_____

_____

In actual use, detergents are designed to allow natural clean up to take place more easily. Results would not be noticeable for a longer period of time.

ACTIVITY C HOW DOES AN OIL SPILL AFFECT LIVING THINGS?

Cartoon removed due to copyright restrictions.

We have all seen pictures of oily sea birds and heard horror stories of damaged fishing grounds resulting from oil spills. The effects of oil are not always so obvious. In this activity you will investigate how oil changes the water and affects plant functions.

MATERIALS For each team or one for entire class: 250 ml beaker, water, 10 ml oil, short piece (5-6 cm) of aquarium plant (Elodea or Anacharis).

PROCEDURE A. Changes in water and plant characteristics.

A group of students did an experiment to find out if oil does anything to water and aquatic (water) plants. They covered two jars of water with black paper so that light could only get in from the top, as it would in a lake. Then they got some Elodea, a water plant, and cut off two pieces that were the same length and had the same number of leaves. One piece of Elodea was placed in each jar of water.

The students decided to observe changes in the appearance of the plants and study two characteristics of the water. They checked the water for dissolved oxygen (D.O.) since they knew that plants and animals take oxygen from the water during respiration.

1. Why is the D.O. test important in a study of bodies of water and life in the water?

_____

_____

They also checked for the amount of acid in the water by measuring the water's "pH." A pH number of less than 7 means the water is acidic. The lower the pH number, the more acid the water is.

2. The amount of acid in the water is related to a gas produced by plants and animals during respiration. What is this gas?

_____

The D.O. and pH in both jars were measured on the first day of the experiment and recorded in the chart below (Day 1).

Then the students created an oil slick in one of the jars. They used motor oil like the kind that is used in cars. On the next three days they repeated their D.O. and pH tests and recorded the results in the chart (Days 2, 3 and 4).

	Clean Water (Jar 1)		Oil Spill (After Day 1) Jar 2	
Day	D.O. (ppm)	pH	D.O. (ppm)	pH
1	10	7	10	7
2	10	7	9	7
3	10	7	7	6
4	10	7	4	5

3. The tests showed that D.O. decreased in the _____ jar but stayed the same in the _____ jar. How can you explain this?

_____

_____

_____

4. The pH in the oil spill jar went down. If both plants were making the gas you named in Question 2, why did the pH drop in one jar and stay the same in the other?

_____

_____

Photosynthesis in plants requires sunlight, water and carbon dioxide. Respiration requires oxygen.

5. Can the plant in the oil spill get light? ____yes ____no

water? ____yes ____no

carbon dioxide? ____yes ____no

oxygen? ____yes ____no

6. Can the plant in clean water get light? ____yes ____no

water? ____yes ____no

carbon dioxide? ____yes ____no

oxygen? ____yes ____no

7. How does an oil spill affect photosynthesis in plants?

_____

Respiration? _____

The students decided to find out if oil was harmful when it got right on the plant itself, so they dipped a piece of Elodea in oil and put it in a cup of clean water. Some of the oil floated off, but the leaves remained coated.

8. Could the leaves of the plant get light? ____yes ____no

water? ____yes ____no

carbon dioxide? ____yes ____no

Predict what happened to the oily plant.

_____

Try this yourself with the materials listed on page 12.

B. Changes in animal populations

The National Academy of Sciences report discussed in Activity A listed the findings of scientists about the effects of oil spills on animals:

1. Petroleum products do not remain in marine organisms after the spill has gone. These products are not concentrated as they pass through the food chain. In the Great Lakes, on the other hand, some organisms do accumulate petroleum materials in their fat.

2. Oil on beaches damages shoreline life. Oil seeps downward into sand and remains there for years. Rocky shorelines can clean themselves naturally through wave action, but bays, estuaries and marshes have few waves. Oil spills in such areas are very damaging.

U.S. Coast Guard photograph, "The NEPCO 140 Incident."

3. Oil causes serious harm to birds by coating their feathers. An oily bird does not float, and it has no insulation against temperature changes. Birds also poison themselves by eating the oil that coats them.

4. Oil is sometimes responsible for smothering communities of animals that live on the sea floor. This is especially important to the shellfishing industry. Most of these areas will eventually become settled again, but some organisms like mussels cannot survive in an oiled area.

   In the Great Lakes, the fresh water cannot hold the heavier types of oils on the surface. The oil sinks and enters the bottom sediments and the food chain.

5. Fish are not affected by oil pollution as much as other organisms. A massive spill such as that from the Amoco Cadiz in 1978 can kill large numbers of fish, but ordinarily fish are able to escape injury from minor accidents.

6. Different petroleum products have different effects on organisms. Diesel or heating oils are most poisonous, while heavy crude and fuel oils are worse for smothering animals. Oil may be more poisonous to freshwater organisms than to sea life, probably because cold lake water slows down evaporation and oils stay in the environment longer.

Answer these questions based on your reading of Part B:

1. Why does the oil spilled in the Great Lakes sink to the bottom while oil on the ocean floats?

_____

_____

2. Describe an oil spill that could kill large numbers of fish.

_____

_____

3. What kinds of petroleum products have the greatest effect on organisms? _____

_____

How do these affect the organisms?

_____

_____

4. Are all areas of the coastline affected in the same way by oil pollution? _____If not, explain differences.

_____

_____

5. Why does oil remain in Great Lakes water longer than in ocean water?

_____

_____

REVIEW QUESTIONS

1. What are the two major sources of oil pollution in the oceans?

_____

_____

2. How does nature clean up oil spills?

3. List three ways that oil can be removed from water.

4. For the methods you listed in #3 above, what damage to the environment might occur if the methods are used?

5. How does oil affect plants? Birds? Bottom animals? Fish?

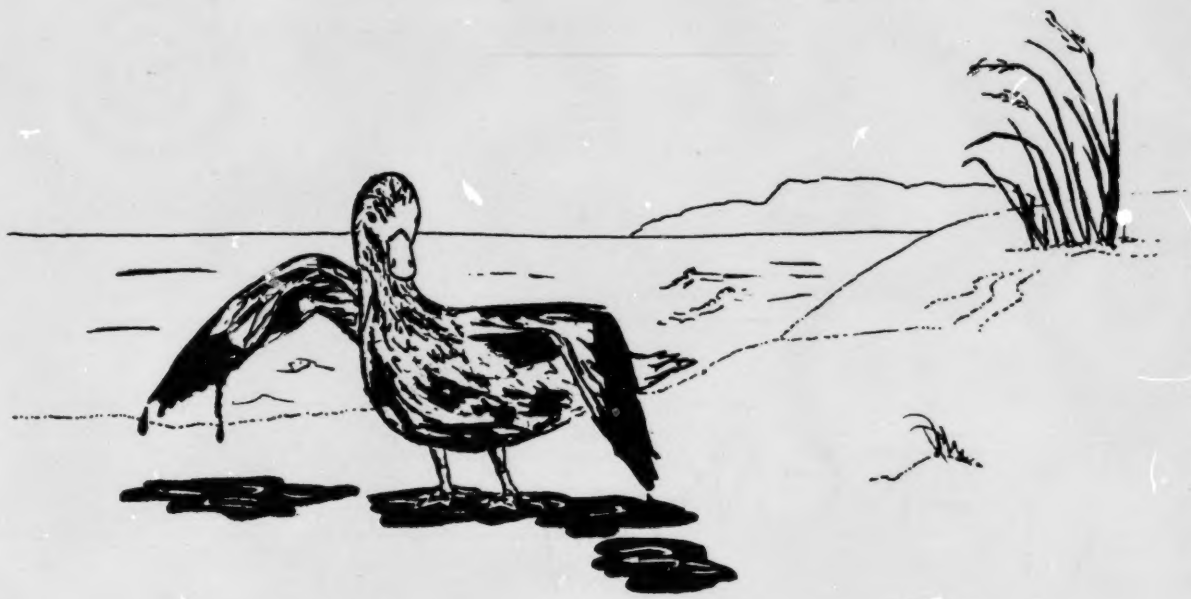
Ohio Sea Grant

OEAGLS- Oceanic Education Activities for Great Lakes Schools

OIL SPILL!

by

Rosanne W. Fortner, The Ohio State University
and
Stephanie Ihle, The Ohio State University



Ohio Sea Grant Program
Charles E. Herdendorf, Program Director
Victor J. Mayer, Principal Investigator

TEACHER GUIDE

OEAGLS Investigation #17
Completed March, 1980

This instructional activity was prepared with the support of National Oceanic and Atmospheric Administration Grant Nos. 04-158-44099, 04-8-M01-170 and NA 79AA-D-00120, and from The Ohio State University. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the authors, and do not necessarily reflect the views of NOAA or the University.

TEACHER GUIDE

Copyright © The Ohio State University Research Foundation, 1980.
All rights reserved.

OIL SPILL

OVERVIEW

This investigation consists of three activities concerning the causes and effects of oil spills and the methods used to clean up these spills in the oceans and the Great Lakes.

Activity A involves the construction and interpretation of a pie graph that shows the sources of petroleum pollution in the oceans. In Activity B, students create a small-scale oil spill in a pan and use various methods to try to clean it up. This helps the students to assess the effectiveness of the methods and to consider what other environmental damages might result from their use. Finally, the effect of oil on living things is illustrated through a dry lab in which dissolved oxygen, pH and plant characteristics are noted in oily and clean water.

PREREQUISITE STUDENT BACKGROUND

Students should have the ability to multiply by a two-digit multiplier, place decimals properly in multiplication, and use a protractor. They should be reminded of basic laboratory safety rules.

MATERIALS

Activity A: protractor and pencil for each student

Activity B: (for each team of students) aluminum "pot pie" pan, water, automotive motor oil (1 can, 10W-30 or similar type), 25 cm piece of twine, handful of straw, handful of sand, alcohol burner, matches, wooden splint, paper towels, 1 ml liquid detergent, medicine dropper, safety glasses, newspaper to cover tables.

Activity C: (optional) 250 ml beaker, water, 10 ml oil, aquarium plant (small sprig), Elodea or Anacharis

OBJECTIVES

When they have completed this investigation, students should be able to:

1. Describe the major sources of oil pollution in the oceans and Great Lakes.
2. Discuss three ways in which oil may be removed from water.
3. Describe the effects of oil on aquatic organisms.

SUGGESTED APPROACH

Each activity will take about one class period of 40-50 minutes. Ample time should be allowed for discussion of the results of the entire investigation.

A film concerning the oil spill from the NEPCO 140 (in the St. Lawrence River in 1976) is available on a free loan basis from the U.S. Coast Guard, 9th Coast Guard District, Cleveland, OH 44199.

"Six Fathoms Deep," a 30-minute film from the Man Builds-Man Destroys series can be rented (1979 price $20) from GPN Films, Box 80669, Lincoln, NE 68501. The film tells the story of several major oil spills and reports some constructive responses to them.

ACTIVITY A WHERE DOES OIL POLLUTION COME FROM?

PROCEDURE

Keywords: metric ton (2204.62 pounds or 1000 kilograms), petroleum, ballast.

Procedures are outlined completely in the Student Guide. It would probably be helpful to go over with students how the "natural seepage" wedge was created in the example.

Completed graphs should have the sections shown in Figure TG-1. The arrangement of the wedges within the circle may differ because of students' using different wedge sides as base lines.

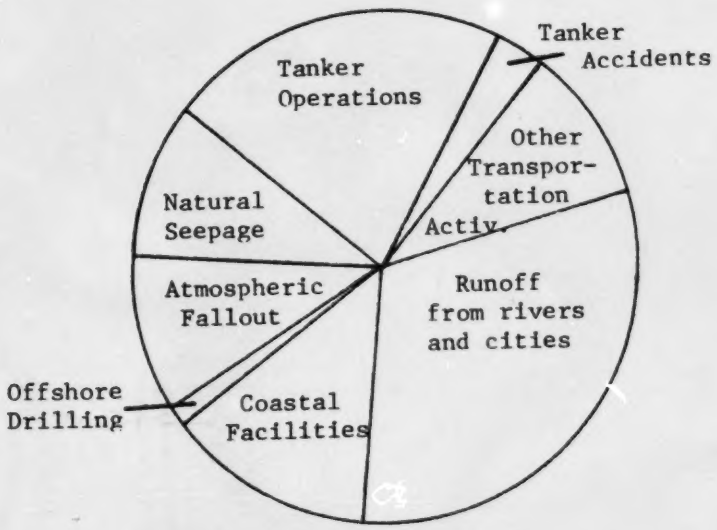


Figure TG-1. Completed graph of petroleum pollution sources.

Answers to questions are as follows:

1. Tanker accidents. Discuss with students some possible reasons why we hear more about tanker accidents than about municipal oil pollution, coastal facilities as polluters, etc.

2. Tanker operations. Much of the tanker industry now avoids the oily ballast problem by using the "Load-on-Top" (LOT) technique. During tank cleaning, dirty water is pumped into holding tanks where the oil separates and rises to the surface. Water from under the oil is pumped out and the remaining contaminated mixture stays in the ship. New cargo is loaded in on top of the old oily water.

3. Oil could escape from offshore drill rigs by breaks in pipelines, "blowouts" from gas in the wells, storm damage to the rigs' stability, or faulty equipment. An offshore drill rig is extremely expensive, however, and pressure for environmental protection is strong. Oil companies have devised numerous safeguards and maintain close observations of weather, equipment and personnel to prevent problems that would result in a spill. The American Petroleum Institute states that, based on its past record, chances of an oil spill from an offshore rig are 5000 to 1.

Students may think of other ways oil could escape. Discussions of such problems and other aspects of oil technology are presented in a readable form in the free booklet "Questions and Answers on Petroleum Operations and Offshore Development," from the American Petroleum Institute, 2101 L Street, NW, Washington, DC 20037.

4. Petroleum could get into rivers from oil dumped on land, oil dumped into streams, truck, rail or barge accidents, structural failure of pipelines, local spills at service stations, etc. Be receptive to a wide range of student ideas.

The "highway streak" could be washed into waterways by rain, snow removal, or street cleaning operations.

5. Answers will vary widely. Accept and discuss all possibilities. Some choices might include disposing of waste motor oil properly, keeping cars maintained so they don't drip oil, not letting gasoline overflow from the gas pump, using fewer petroleum products so the U.S. doesn't have to import or drill for so much.

6. The Atlantic Ocean gets the most oil pollution. This is understandable simply considering world geography. Most of the world's major industrial nations and petroleum exporting countries use the Atlantic shipping lanes. The heavier traffic and port activity results in a higher incidence of accidents.

ACTIVITY B HOW CAN AN OIL SPILL BE CLEANED UP?

PROCEDURE

Keywords: containment, boom, adsorption. This activity originated as part of the University of Delaware's Project COAST. See the REFERENCES list on page 6 for the address for ordering the original complete module.

ANSWERS TO STUDENT GUIDE QUESTIONS

I. Containment.

2. The string should contain the oil. If too much oil is added, however, it will overflow the boom. You may want to adjust the amount of oil students add. For lighter oils, spreading is greater and you should decrease the amount used.

3. Answers will depend on how thorough the students are. Most of the oil can probably be removed, but it will be mixed with water. Further treatment would be necessary before the oil could be re-used.

II. Removal.

A. By burning.

3. The oil should not burn. In trying to explain why, students may explain that "it is wet." In reality, the oil will not burn because it is a type that does not contain flammable substances. Petroleum fractions are separated with their uses in mind. Some contain volatile mixtures while others (like this oil) are mostly inert.

4. If the oil burned, damage might occur in the form of air pollution.

5. No. Not all types of oil will burn, and if they do burn they could cause other environmental damage.

B. By sinking.

2. Most of the oil will sink when sand is added. However, if left standing the oil may escape and bubble to the surface again.

3. Bottom organisms could be smothered. Contaminants could be trapped in the bottom sediments so that future burrowing animals would be poisoned.

4. You should know what bottom organisms you would damage and whether the oil is light enough to surface again.

5. No. There is too much potential for damaging bottom organisms (such as shellfish) and no promise of permanent oil removal.

C. By adsorption.

2. Oil sticks to all the surfaces of the straw.

3. Picking up the straw or burning the straw are the most frequent suggestions. Both work fairly well, especially if clean straw is added and removed several times.

NOTE: If students wish to burn the oily straw, this activity should be supervised outdoors. Black greasy smoke may result.

4. This is a better way than most, especially if the oily straw is mechanically removed instead of burned.

D. By detergents.

2. A milky suspension is formed. Neither drop is visible any more.

3. This method does not clean up oil. It only breaks it up into tiny droplets that aren't as noticeable.

4. The detergents could harm water animals and reduce the "waterproof" characteristics of ducks and other water birds.

ACTIVITY C HOW DOES AN OIL SPILL AFFECT LIVING THINGS?

MATERIALS

If done as a "dry lab," only the chart in the Student Guide is required. D. O. measurement is time consuming and requires numerous dangerous chemicals, so actually doing the experiments in class is not recommended. You may wish to demonstrate the processes yourself, in whichcase you would need pH test paper (range 5-9) and the materials listed in the Appendix. Hach Chemical Company also prepares field test kits for D.O. These include pre-measured packets of chemicals so that precision is high and danger to users is minimized.

PROCEDURE

Keywords: pH, dissolved oxygen, photosynthesis, respiration

ANSWERS TO STUDENT GUIDE QUESTIONS

A-1. Living things must have oxygen for respiration. Low levels of oxygen in the water can cause death.

2. Carbon dioxide.

3. D.O. decreased in the oil spill jar but stayed the same in the clean jar. The plant's respiration is using up the oxygen dissolved in the water and oxygen is no longer available from the air above the water's surface. The plant makes oxygen during photosynthesis, but no light is available for this process.

4. In the clean tank, extra carbon dioxide (CO_2) can escape into the air. The CO_2 produced by plant respiration in the oil jar stays in the water and causes the water to become more acidic.

$$CO_2 + H_2O \quad H_2CO_3 \quad \text{(Carbonic Acid)}$$

5. light--no; water--yes; CO_2 and O_2--yes, but only what's in the water.

6. light--yes; water--yes; CO_2--yes; O_2--yes.

7. Photosynthesis decreases because there is no light penetrating the water. CO_2 is available, but the process cannot go on with light. Respiration fails without oxygen.

8. light--no; water--no; CO_2--no. The plant died within a short time.

B-1. Since ocean water contains salt, it is more dense and buoys up the less dense oil. In the fresh water of the Great Lakes some oil fractions are heavier than water and will sink to the bottom.

2. The spill would have to be of great extent, covering large areas of surface water. Sunlight and oxygen are prevented from entering the water.

3. Diesel and heating oils poison living things, while heavy crude and fuel oils smother animals.

4. No. Different coastal features are affected differently. Rocky shores and heavy wave action break up oil. Rocks do not absorb oil, but plants, sand and mud in bays and estuaries do absorb it. Areas with little wave action hold the oil longer.

5. Colder lake temperatures slow the evaporation of oils. Warmer ocean temperatures and turbulent wave action increase the rates of evaporation and break-up of oil spills.

REVIEW QUESTIONS

1. Runoff from rivers and cities, and tanker operations.

2. Wind and currents spread the oil out. Some of it evaporates, and some is consumed by bacteria called petrophiles.

3. Oil may be removed by adsorption, burning, sinking and detergents. Students should list three of the four ways.

4. Three of the four answers below:

Adsorption--If adsorpent is mechanically removed, little environmental damage occurs. If burned, however, it creates air pollution.

Burning--Causes air pollution.

Sinking--Lightweight oils will re-surface. Heavy oils may smother bottom organisms and trap contaminants in bottom sediments.

Detergents--Does not really remove oil, but speeds natural processes of clean-up. Could harm water animals and reduce "waterproof" characteristics of shore birds.

5. Plants coated with oil die without light, water and gas exchange. Plants beneath an oil slick will also die for lack of light.

   Birds with oily feathers will drown, die of exposure or poison themselves by eating oil. Bottom animals may be smothered. Fish can usually swim away to unaffected areas, but their food supplies and breeding grounds may be damaged.

REFERENCES

Exxon Corporation, 1978. Fate and Effects of Oil in the Sea. Public Affairs Department, Exxon Corporation, 1251 Avenue of the Americas, New York, NY 10020. This free booklet compiles research on sources of petroleum going into waters and the effects of oil on living and nonliving parts of the environment. Industry viewpoint emerges.

Hull, E. W. Seabrook, 1978. "Oil Spills: The Causes and the Cures." Sea Frontiers 24(6): 360-369. Subjects similar to above. Layman's language, environmental viewpoint.

"Oil Eaters," Time Magazine 106:46. September 22, 1975. Tells of discovery of bacterial genus of petrophiles. Research on effects.

Project COAST materials: #222. Dissolved Oxygen Measured Qualitatively; #301. The Oil Spill Problem. Obtain from Project COAST, 310 Willard Hall, University of Delaware, Newark, DE 19711. COAST #222 is the source of the Appendix activity and includes extensions of the concept of dissolved oxygen. COAST #301 is the source of Activity B. The original contains student background readings on oil spills, other experiments on oil effects, and activities related to oil spill movements and tanker efficiency. A valuable source of further information and extension materials.

EVALUATION ITEMS

1. Which source supplies the greatest amount of petroleum pollution going into the oceans?

   1. Natural seepage
   2. Offshore drilling
   3. Tanker operations and accidents
   *4. Runoff from rivers and cities

2. An oil freighter carrying no oil fills its tanks with water to

   1. carry fresh water to cities along the seacoast.
   *2. stabilize the ship.
   3. flush out the cargo space.
   4. carry tropical fish to pet stores in the United States.

3. All but one of the following reasons explain why the Atlantic Ocean gets the most oil pollution. Which one?

*1. It is the largest ocean.
2. The world's major cities are located on the Atlantic.
3. Many oil tankers travel across it.
4. There is much offshore drilling along the Atlantic coast.

4. A boom is

1. another name for a very large oil tanker.
2. the tallest part of an offshore oil rig.
*3. an apparatus used to contain an oil spill.
4. the Coast Guard's nickname for oil spills.

5. One method of removing an oil spill is by burning the oil. Sometimes this method does not work because

1. the oil is wet.
*2. some types of oil contain no flammable substances.
3. lighting an oil spill is hazardous business.
4. burning oil spills are uncontrollably dangerous.

6. Which oil spill removal method does the least environmental damage?

1. Sinking
2. Burning
3. Detergents
*4. Adsorption

7. When an oil spill occurs in U.S. waters, who is supposed to pay for the clean-up costs?

*1. The spiller
2. The taxpayers
3. The Coast Guard
4. The Federal government

8. Why does oil float on water?

1. Oil is usually spilled on the water surface.
2. Oil is warmer than water and rises.
3. Ocean currents keep oil pushed to the surface.
*4. Oil is less dense than water.

9. Photosynthesis in plants requires all but which one of the following?

1. Sunlight
2. Water
*3. Soil
4. Carbon dioxide

10. What effect does an oil spill have on aquatic life?

1. Organisms suffocate for lack of dissolved oxygen.
2. Excess acid forms from increased levels of carbon dioxide.
3. Oil will coat the organism and restrict life processes.
*4. All of the above.

DETECTION OF DISSOLVED OXYGEN BY THE METHYLENE BLUE METHOD

from "Dissolved Oxygen Measured Qualitatively," Project COAST, University of Delaware

This investigation will show the relative amounts of dissolved oxygen contained in a water sample. Methylene blue is the indicator. The presence of dissolved oxygen turns the sample with the indicator blue. In the absence of oxygen the sample will retain its original color.

Materials

5 test tubes

500 ml beaker for test solution

250 ml beaker for methylene blue solution

scale

spatula

eyedropper

source of heat

methylene blue solution

plastic or rubber gloves

tap water

water samples (from aquaria)

small graduated cylinder

test tube holder

test tube rack

test solution (see below)

Use fresh solutions. The test solution is a buffer solution and can be made by heating 8 g KOH in 300 ml water. Cool and stir in 10 g dextrose (glucose). To make the methylene blue solution, mix 0.25 g methylene blue in 100 ml water. Use "reagent" grades. These chemicals should be available in junior high and high school laboratories.

Procedure

1. Put 5 ml of tap water and 5 ml of test solution into one test tube. Add one drop of methylene blue solution and mix gently. a. What color is it? _____ Let the solution sit. b. How long does it take for the color to disappear? _____ Stopper the test tube and shake for 30 seconds. c. Now what color is the water? _____ d. How long does the color last? _____ e. What gas was being added to the water by shaking it? _____ Which color lasted the longest? _____ the shortest? _____ When water is heated, much of the oxygen is removed. This is why boiled water can taste flat; it lacks oxygen. Thus, the longer the blue color persists, the greater the concentration of dissolved oxygen in the sample.

4. Now that you see how methylene blue works in tap water, let's use it to test some unknown samples of water from the two aquaria in Activity C. While sampling, be sure to avoid aerating and warming the sample. Because this water may have organisms and chemicals in it which may in time react with the oxygen, the dissolved oxygen should be measured soon after the sample is taken.

   Measure 5 ml of the sample into a test tube. Add 5 ml of test solution and a drop of methylene blue solution. Shake the tube once to distribute the methylene blue throughout the solution. How long does the blue color last in each sample? Record your results in the second column of the table below. In column 3, Relative Amount of D.O. in Water, assign the number 10 to the tap water sample. If you test any water with a longer reaction time than tap water, it has more D.O. Record an 11 or 12 in the Relative Amount column. If the water sample you test changes color

faster than tap water, record a number less than ten (the lower the number, the faster the reaction).

This method does not tell the D.O. in parts per million (ppm) as called for in the Student Guide, but it does show whether D.O. is increasing or decreasing.

PRESENCE OF OXYGEN IN VARIOUS SAMPLES OF WATER

Sample No.	Time of Color Reaction (Observation from Procedure 1.)		Relative Amount of D.O. in Water		Source of Water
1	No oil	Oil	No Oil	Oil	Tap water
Day 1					Aquaria in Activity C
2					"
3					"
4					"